Aircraft Ignition Cable Connector

Field of Invention

The invention pertains to high voltage ignition cable connectors. More particularly, the invention relates to moisture proof connectors for spark plugs used in piston-type aircraft engines.

Background of the Invention

Various types of high voltage ignition cable connectors have been developed for use in aircraft engines. U.S. Patent No. 4,150,865 issued to *Iliff* discloses a spark plug connector including a threaded cap through which the high-tension lead passes. The cap threadedly engages an externally threaded metal cylindrical barrel encasing the spark plug insulator and contact. A coil spring and compressible tubular grommet, held in place by the cap, serve to seal the cable end and spark plug against moisture while providing a secure contact between the cable and the contact.

U.S. Patent No. 2,109,030 issued to *Nowosielski*, is directed to an ignition apparatus and relates to spark plugs of aviation engines. The intent is to enclose all parts of the spark plug system so that high-tension current-carrying systems are protected and shielded so as to prevent interference with reception of radio signals. Insulating material covers the ignition wire with an outer metallic sheath. A swivel connection is soldered to the sheath which is detachable from a coupling nut, all of which provide the necessary protection.

U.S. Patent No. 3,334,326, issued to *Bedsore et al.* is directed to a moisture proof connector for spark plugs associated with internal combustion engines. The moisture proof connector of this reference is especially useful in aircraft type engines that are susceptible to

fouling due to the accumulation of moisture and dirt in the spark plug well. The insulated cable and grommet is a wire-meshed reinforced insulated conduit that is fastened to the upper end of the metal ferrule. The conduit, with its wire-meshed construction provides for the flexibility necessary in order to protect the cable.

U.S. Patent No. 4,978,309 issued to *Straub* describes an igniter cable connector that is used in the high voltage electrical systems of an aircraft engine. The patent is intended to avoid flashover between the igniter insulator and the connector insulator and is accomplished by introducing a resilient seal between the insulators. In a first embodiment of the invention, a resilient annular seal is positioned on an end of the connector insulator adjacent to and surrounding the contact. The seal engages the contact as well as the insulator end and the wall of the igniter insulator bore end section. The seal has sufficient resilience to permit insertion of the seal into the igniter insulator bore without interference with the attachment of the connector to the igniter.

U.S. Patent No. 2,312,757 issued to *Frei* discloses a radio shielded ignition apparatus, particularly to the connecting means for high-tension conductors in order to provide radio-shielded ignition circuits for internal combustion engines. The patent provides for the connection of the electrode with a source of high tension current by means of an insulated conductor. The conductor is shielded to prevent interference by means of a flexible metallic conduit along with a rigid metallic elbow wherein the conduit and elbow are connected together by a ferrule that telescopically receives the adjacent ends thereof.

While other variations exist, the above-described designs for aircraft ignition cable connector are typical of those encountered in the prior art. It is an objective of the present invention to provide a securely fastenable aircraft ignition cable connector that provides

superior shielding for radio-frequency signals from high voltage ignition noise. It is a further objective to provide such shielding in a connector that provides complete sealing against moisture and dirt found in the aviation environment. It is yet a further objective to provide a connector with a flexible elbow tube that may be easily formed to a variety of required configuration without the use of special tools. It is an additional objective of the invention that the flexible elbow tube be capable of retaining its shape once formed, to simplify installation after spark plug service. It is a final further objective of the invention to provide the above described capabilities in an inexpensive and durable connector which is capable of extended duty cycles.

While some of the objectives of the present invention are disclosed in the prior art, none of the inventions found include all of the requirements identified.

Summary of the Invention

The present invention addresses all of the deficiencies of prior aircraft ignition cable connector inventions and satisfies all of the objectives described above.

An aircraft ignition cable connector of the present invention may be constructed from the following components. A radio-shielded ignition cable is provided. The cable has an outer insulating cover, a shielding conductor, an inner insulating layer, and a center conductor. A flexible, conducting, elbow tube is provided. The elbow tube has a first end and a second end and is fixedly and conductively attached at its first end to the shielding conductor of the cable. The elbow tube is capable of retaining a particular shape after bending.

A sealing sleeve is provided. The sleeve joins the outer insulating cover to the first end of the elbow tube. A threaded nut is provided. The nut has a central orifice through it, a

first end, a second end, a retaining lip at the first end and an internal thread extending from the second end toward the retaining lip. A conducting ferrule is provided. The ferrule being cylindrical in shape, having a central orifice though it, and having a body portion and a retaining portion.

The body portion has a first end and a second end and is sized and shaped to fit slidably through the orifice in the threaded nut. The body portion is fixedly and conductively attached at its first end to the second end of the elbow tube. The retaining portion has a first end and a second end. The first end extends from the second end of the body portion and is sized and shaped to bear rotatably against the retaining lip of the threaded nut. The second end of the retaining portion includes a cylindrical recess.

A coil spring is provided. The coil spring has a first end and a second end. The first end is sized and shaped to rotatably engage the cylindrical recess. A cylindrical grommet is provided. The grommet has a first end, a second end, is formed of resilient, insulating material. The grommet is sized and shaped to fit slidably over the inner insulating layer of the cable. The grommet including a surrounding shoulder located between the first end and the second end. A washer is provided. The washer is sized and shaped to fit slidably over the first end of the grommet and bear against the surrounding shoulder. The coil spring is sized and shaped to surround the first end of the grommet and bear against the washer.

A spark plug lead button is provided. The button is fixedly and conductively attached to the center conductor of the cable adjacent the second end of the grommet. A cylindrical protector cap is provided. The cap is formed of insulating material and including an inner chamber and an external thread. The thread is size and shaped to engage the internal thread of the threaded nut.

In use, the protector cap is unthreaded from the threaded nut and the cable connector is inserted into a spark plug of an aircraft engine with the spark plug lead button bearing against a central spark plug conductor. When the threaded nut is threaded onto an external thread of the spark plug, the coil spring will be compressed, causing the spark plug lead button to bear against the central spark plug conductor, thereby providing a moisture-resistant connection between the cable and the sparkplug.

In a variant of the invention, the flexible, conducting, elbow tube is formed from a sheet of malleable metallic material. The sheet has first and second, opposed parallel edges and third and fourth, opposed parallel edges normal to the first and second edges. The sheet has a series of single, back to back folds parallel to the third and fourth edges and is formed about a cylindrical mandrel with a long axis of the mandrel perpendicular to the folds. The first and second edges are joined to form an open-ended cylindrical tube.

In a further variant, the flexible, conducting, elbow tube is formed from a sheet of malleable metallic material. The sheet has first and second, opposed parallel edges and third and fourth, opposed parallel edges normal to the first and second edges. The sheet has a series of single, back to back folds parallel to the third and fourth edges. Lower portions of the folds are doubled back upon themselves so as to provide four layers of metallic material adjacent a lower surface of the sheet. The sheet is formed about a cylindrical mandrel with the lower surface outermost with a long axis of the mandrel perpendicular to the folds. The first and second edges are joined to form an open-ended cylindrical tube that has a reinforced outer surface.

Yet another variant of the invention may be constructed from the following component. A radio-shielded ignition cable is provided. The cable has an outer insulating

cover, a shielding conductor, an inner insulating layer, and a center conductor. A flexible, conducting, elbow tube is provided. The elbow tube has a first end and a second end and is fixedly and conductively attached at its first end to the shielding conductor of the cable. The elbow tube is capable of retaining a particular shape after bending.

A sealing sleeve is provided. The sleeve joins the outer insulating cover to the first end of the elbow tube. A threaded nut is provided. The nut has a central orifice through it, a first end, a second end, a retaining lip at the first end and an internal thread extending from the second end toward the retaining lip. A conducting ferrule is provided. The ferrule being cylindrical in shape, having a central orifice though it, and having a body portion and a retaining portion.

The body portion has a first end and a second end and is sized and shaped to fit slidably through the orifice in the threaded nut. The body portion is fixedly and conductively attached at its first end to the second end of the elbow tube. The retaining portion has a first end and a second end. The first end extends from the second end of the body portion and is sized and shaped to bear rotatably against the retaining lip of the threaded nut. The second end of the retaining portion includes a cylindrical recess.

A cylindrical grommet is provided. The grommet has a first end, a second end, is formed of resilient, insulating material. The grommet is sized and shaped to fit slidably over the inner insulating layer of the cable. The grommet includes a surrounding shoulder located adjacent to the first end. The shoulder is sized and shaped to fit frictionally within the cylindrical recess in the second end of the retaining portion of the ferrule.

A spark plug lead button is provided. The button is fixedly and conductively attached to the center conductor of the cable adjacent the second end of the grommet. A cylindrical

protector cap is provided. The cap is formed of insulating material and includes an inner chamber and an external thread. The thread is size and shaped to engage the internal thread of the threaded nut.

In use, the protector cap is unthreaded from the threaded nut and the cable connector is inserted into a spark plug of an aircraft engine with the spark plug lead button bearing against a central spark plug conductor. When the threaded nut is threaded onto an external thread of the spark plug, the spark plug lead button will bear against the central spark plug conductor, thereby providing a moisture-resistant connection between the cable and the sparkplug.

The above variant may be used with either of the above-described flexible elbow tube designs.

Description of the Drawings

Figure 1 is an exploded side elevational view of the preferred embodiment of the invention including protective cap for a connector;

Figure 2 is a plan view of a folded, metallic sheet from which a first embodiment of a flexible, conducting, elbow tube is formed;

Figure 2a is perspective view of the **Figure 2** embodiment being formed about a mandrel;

Figure 2b is a side elevation of the first embodiment of a flexible, conducting, elbow tube;

Figure 2c is an enlarged, cross-sectional perspective of a section of the **Figure 2b** embodiment taken along the line **2c**;

Figure 3 is an exploded side elevational view of a second embodiment of the invention including protective cap for a connector;

Figure 3a is a plan view of the **Figure 3** connector and a sparkplug of the type attachable to said connector;

Figure 4 is a plan view of a folded, metallic sheet from which a second embodiment of a flexible, conducting, elbow tube is formed;

Figure 4a is perspective view of the **Figure 4** embodiment being formed about a mandrel;

Figure 4b is a side elevation of the first embodiment of a flexible, conducting, elbow tube;

Figure 4c is an enlarged, cross-sectional perspective of a section of the **Figure 4b** embodiment taken along the line **4c.**

Detailed Description of the Preferred Embodiment

Figure 1 illustrates an aircraft ignition cable connector **10** of the present invention that may be constructed from the following components. A radio-shielded ignition cable **14** is provided. The cable **14** has an outer insulating cover **18**, a shielding conductor **22**, an inner insulating layer **26**, and a center conductor **30**. A flexible, conducting, elbow tube **34** is provided. The elbow tube **34** has a first end **38** and a second end **42** and is fixedly and conductively attached at its first end **38** to the shielding conductor **22** of the cable **14**. The elbow tube **34** is capable of retaining a particular shape after bending.

A sealing sleeve **46** is provided. The sleeve **46** joins the outer insulating cover **18** to the first end **38** of the elbow tube **34**. A threaded nut **50** is provided. The nut **50** has a central

orifice **54** through it, a first end **58** , a second end **62**, a retaining lip **66** at the first end **58** and an internal thread **70** extending from the second end **62** toward the retaining lip **66**. A conducting ferrule **74** is provided. The ferrule **74** being cylindrical in shape, having a central orifice **78** though it, and having a body portion **82** and a retaining portion **86**.

The body portion **82** has a first end **88** and a second end **90** and is sized and shaped to fit slidably through the orifice **54** in the threaded nut **50**. The body portion **82** is fixedly and conductively attached at its first end **88** to the second end **42** of the elbow tube **34**. The retaining portion **86** has a first end **94** and a second end **98**. The first end **94** extends from the second end **90** of the body portion **82** and is sized and shaped to bear rotatably against the retaining lip **66** of the threaded nut **50**. The second end **98** of the retaining portion **86** includes a cylindrical recess **102**.

A coil spring **106** is provided. The coil spring **106** has a first end **110** and a second end **114**. The first end **110** is sized and shaped to rotatably engage the cylindrical recess **102**. A cylindrical grommet **118** is provided. The grommet **118** has a first end **122**, a second end **126**, is formed of resilient, insulating material. The grommet **118** is sized and shaped to fit slidably over the inner insulating layer **26** of the cable **14**. The grommet **118** including a surrounding shoulder **130** located between the first end **122** and the second end **126**. A washer **134** is provided. The washer **134** is sized and shaped to fit slidably over the first end **122** of the grommet **118** and bear against the surrounding shoulder **130**. The coil spring **106** is sized and shaped to surround the first end **122** of the grommet **118** and bear against the washer **134**.

A spark plug lead button **138** is provided. The button **138** is fixedly and conductively attached to the center conductor **30** of the cable **14** adjacent the second end **126** of the

grommet **118**. A cylindrical protector cap **142** is provided. The cap **142** is formed of insulating material and including an inner chamber **146** and an external thread **150**. The thread **150** is size and shaped to engage the internal thread **70** of the threaded nut **50**.

In use, the protector cap **142** is unthreaded from the threaded nut **50** and the cable connector **10** is inserted into a spark plug (not shown) of an aircraft engine (not shown) with the spark plug lead button **138** bearing against a central spark plug conductor (not shown). When the threaded nut **50** is threaded onto an external thread (not shown) of the spark plug, the coil spring **106** will be compressed, causing the spark plug lead button **138** to bear against the central spark plug conductor, thereby providing a moisture-resistant connection between the cable **14** and the sparkplug.

In a variant of the invention, as illustrated in **Figures 2, 2a, 2b** and **2c**, the flexible, conducting, elbow tube **34** is formed from a sheet **146** of malleable metallic material. As shown in **Figure 2**, the sheet **146** has first **150** and second **154**, opposed parallel edges and third **158** and fourth **162**, opposed parallel edges normal to the first **150** and second **154** edges. As shown in **Figure 2c**, the sheet **146** has a series of single, back-to-back folds **166** parallel to the third **154** and fourth **158** edges and is formed about a cylindrical mandrel **170** with a long axis **174** of the mandrel **170** perpendicular to the folds **166,** as illustrated in **Figure 2a**. As illustrated in **Figure 2b**, the first **150** and second **154** edges are joined to form an open-ended cylindrical tube **178**.

In a further variant, as illustrated in **Figures 4, 4a, 4b** and **4c**, the flexible, conducting, elbow tube **34** is formed from a sheet **182** of malleable metallic material. As shown in **Figure 4**, the sheet **182** has first **186** and second **190**, opposed parallel edges and third **194** and fourth

198, opposed parallel edges normal to the first **186** and second **190** edges. As shown in **Figure 4c**, the sheet **182** has a series of single, back to back folds **202** parallel to the third **194** and fourth **198** edges. Lower portions **206** of the folds **202** are doubled back upon themselves so as to provide four layers **210** of metallic material adjacent a lower surface **214** of the sheet **182**. The sheet **182** is formed about a cylindrical mandrel **218** with the lower surface **214** outermost with a long axis **222** of the mandrel **218** perpendicular to the folds **202** as illustrated in **Figure 4a**. As illustrated in **Figure 4b**, the first **186** and second **190** edges are joined to form an open-ended cylindrical tube **226** that has a reinforced outer surface **230**.

As illustrated in **Figures 3** and **3a**, yet another variant of the invention may be constructed from the following component. A radio-shielded ignition cable **234** is provided. The cable **234** has an outer insulating cover **238**, a shielding conductor **242**, an inner insulating layer **246**, and a center conductor **250**. A flexible, conducting, elbow tube **254** is provided. The elbow tube **254** has a first end **258** and a second end **262** and is fixedly and conductively attached at its first end **258** to the shielding conductor **242** of the cable **234**. The elbow tube **254** is capable of retaining a particular shape after bending.

A sealing sleeve **260** is provided. The sleeve **260** joins the outer insulating cover **238** to the first end **258** of the elbow tube **254**. A threaded nut **266** is provided. The nut **266** has a central orifice **270** through it, a first end **274**, a second end **278**, a retaining lip **282** at the first end **274** and an internal thread **286** extending from the second end **278** toward the retaining lip **282**. A conducting ferrule **288** is provided. The ferrule **288** being cylindrical in shape, having a central orifice **290** though it, and having a body portion **294** and a retaining portion **298**.

The body portion **294** has a first end **302** and a second end **306** and is sized and shaped to fit slidably through the orifice **270** in the threaded nut **266**. The body portion **294** is fixedly

and conductively attached at its first end **302** to the second end **262** of the elbow tube **254**. The retaining portion **298** has a first end **310** and a second end **314**. The first end **310** extends from the second end **306** of the body portion **294** and is sized and shaped to bear rotatably against the retaining lip **282** of the threaded nut **266**. The second end **314** of the retaining portion **298** includes a cylindrical recess **318**.

A cylindrical grommet **322** is provided. The grommet **322** has a first end **326**, a second end **330**, is formed of resilient, insulating material. The grommet **322** is sized and shaped to fit slidably over the inner insulating layer **246** of the cable **234**. The grommet **322** includes a surrounding shoulder **328** located adjacent to the first end **326**. The shoulder **328** is sized and shaped to fit frictionally within the cylindrical recess **318** in the second end **314** of the retaining portion **298** of the ferrule **288**.

A spark plug lead button **334** is provided. The button **334** is fixedly and conductively attached to the center conductor **250** of the cable **234** adjacent the second end **330** of the grommet **322**. A cylindrical protector cap **254** is provided. The cap **254** is formed of insulating material and includes an inner chamber **258** and an external thread **262**. The thread **266** is size and shaped to engage the internal thread **286** of the threaded nut **266**.

In use, the protector cap **254** is unthreaded from the threaded nut **266** and the cable connector **10** is inserted into a spark plug **340** of an aircraft engine (not shown) with the spark plug lead button **334** bearing against a central spark plug conductor (not shown). When the threaded nut **266** is threaded onto an external thread (not shown) of the spark plug, the spark plug lead button **334** will bear against the central spark plug conductor, thereby providing a moisture-resistant connection between the cable **234** and the sparkplug **340**.

The above variant may be used with either of the above-described flexible elbow tube **34, 254** designs. The aircraft ignition cable connector mechanism **10** has been described with reference to particular embodiments. Other modifications and enhancements can be made without departing from the spirit and scope of the claims that follow.

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